COLD-IN-PLACE ASPHALT CEMENT CONCRETE RECYCLING

(General Rewrite)

GENERAL

Cold-in-place recycling is a method of reusing the Asphalt Cement Concrete surface. No material is wasted or removed. All work takes place on the existing roadway. The existing ACC surface material is scarified to the specified depth, sized to the specified gradation (or maximum particle size) mixed with the specified additives and deposited to the specified width and depth. This shall be accomplished in a continuous movement with the appropriate equipment. The spread material shall be compacted to the required density with rubber-tired and steel-wheeled rollers.

This procedure should be limited to projects with low volume traffic (i.e., under 2000 vpd and a structurally adequate road). (**NOTE:** Projects with insufficient subgrade support should not be candidates for this type of rehabilitation.) A minimum 50 mm (2 in) wearing surface should be placed over this base to preserve its integrity.

JOB MIX FORMULA

The emulsion added is to be approximately 1.4 L/m²/25 mm (0.3 gal/yd.²/in.) of compacted thickness as a starting point. Final adjustment of asphalt content is to be made to obtain a durable base (based on the need to minimize deformation and cracking).

EMULSION SAMPLING

A one-liter (one-quart) sample of emulsion shall be obtained each day. The sample from the first day and each third day shall be forwarded to the Transportation Center Laboratory for testing. The other samples shall be retained for submission in the event of a failing test.

1. The laboratory will determine the percent residue of the emulsion sample. The Central Materials Laboratory may conduct further qualifying tests.

MIXTURE SAMPLING

Sample recycled material from the roadway using sampling methods described in Materials I.M. 322. Three 15 kg (30 lb.) samples placed in separate air tight bags or containers will be required per day. The sample must be taken from the roadway after the material has been mixed and leveled by the screed and before rolling.

The first sample of the day shall be promptly delivered to the appropriate Transportation Center Laboratory for Marshall Density determination. The remaining two samples of the day may be sent the following day as "back-up."

LABORATORY TESTING PROCEDURE

1. The appropriate laboratory receives a 15 kg (30 lb.) sample and removes a 2000 -2500 gram sample for determining the maximum specific gravity (Rice Method I.M. 350).

2. The moisture content of the Maximum Specific Gravity sample is determined by drying the entire sample to a constant dry mass in an oven at a temperature not to exceed 135°C (275°F).

   Moisture determination will be calculated using the following formula:

$$\%\,\text{MOISTURE} = \frac{(\text{WET MASS RICE SAMPLE - DRY WT. RICE SAMPLE})(100)}{\text{DRY MASS RICE SAMPLE}}$$

   NOTE: All weighing of the sample shall be recorded to the nearest 0.5 gm.

   Example:

   Given Wet Mass Rice Sample = 2250 gms
   Given Dry Mass Rice Sample = 2185 gms

$$\%\ \text{MOISTURE} = \frac{(2250 - 2185)(100)}{2185} = 3.0\%$$

   The materials used in determining the moisture content will also be used to determine the Maximum Specific Gravity (Rice Method I.M. 350).

3. The remainder of this 15 kg (30 lb.) sample shall be used to compact Marshall Density specimens using the Marshall hammer. Molds shall be at room temperature. Do not use paper disks. Plastic or wax-paper disks will work, or the base and pounding head may be coated with a thin layer of light oil and no disks used.

4. Marshall molds shall be pre-measured and pre-weighed. Determine the mass of each mold to be used to the nearest 0.5 gram. Determine the inside diameter of each mold to the nearest 0.025 mm (0.001 in) (Central Laboratory can do this.). Prepare volume tables from the diameter measurement of each mold for heights of the specimen ranging from 60 mm (2.40 in) to 65 mm (2.60 in) in 0.25 mm (0.01 in) increments.

5. Prepare three specimens by using the Marshall hammer and applying 75 blows to each side. Remove the mold from the base and weigh the mold and specimen to the nearest 0.5 gram. Determine the mass of the specimen by subtracting the mass of the mold. Remove the specimen from the mold and measure the height to the nearest 0.025 mm (0.001 in.) using a dial indicator or suitable caliper. Take a minimum of four measurements, average them, and round the average to the nearest 0.25 mm (0.01 in).

If the specimen is too tender to handle or distorts when removed from the mold, the following alternate procedure may be used to determine the height of the specimen:

Determine the height of the plateau on the base (This is the area of the base that the mold fits over.) to the nearest 0.025 mm (0.001 in). While pounding, the collar must be kept firmly in place on top of the mold for both sides in order to keep the mold firmly against the base. When compaction is completed, remove the collar, but do not remove the mold from the base. Using a straight edge of known thickness laid across the mold measure down to the specimen avoiding any surface voids that would affect the readings. Take a minimum of four measurements. The height of the specimen can be determined by subtracting the height of the plateau and the average of the measurements from the height of the mold used, then adding the thickness of the straight edge.

6. Determine the bulk volume of the Marshall specimens using the volume tables prepared for the particular mold used.

$$\text{Laboratory Wet Density (kg/m}^3\text{)} = \frac{\text{Specimen Mass (grams)}}{(\text{Specimen Volume, m}^3\text{})(1000)}$$

$$\text{Laboratory Wet Density (lb./ft.}^3\text{)} = \frac{\text{Specimen Mass (grams)}}{(453.6\ \text{gms/lb.})(\text{Specific Volume, ft.}^3\text{})}$$

Calculate the Dry Marshall Density and the laboratory specific gravity using the following formulas:

$$\text{Dry Marshall Density kg/m}^3\ \text{(lb./ft.}^3\text{)} = \frac{\text{Laboratory Wet Density (100)}}{100 + \text{Percent Moisture}}$$

$$\text{Laboratory sp gr} = \frac{\text{Dry Marshall Density}}{1000\ (\text{kg/m}^3)} = \frac{\text{Dry Marshall Density}}{62.4\ (\text{lbs./ft.}^3)}$$

$$\text{Percent Voids} = 100 - \frac{(100)(\text{Laboratory sp gr})}{\text{RICE sp gr}}$$

NOTE: The terms RICE Sp Gr and Maximum Sp Gr are synonymous. Variations in Laboratory Sp Gr of more than 0.050 between successive samples shall be investigated promptly. Testing of backup samples shall be included in the investigation and test results averaged for the day.

ROADWAY TESTING PROCEDURE

1. The project inspection personnel shall select and mark the field density test locations by dividing the day's run into seven equal subsections (Ref: Construction Manual 8.13, B-2.) A random spot in each subsection shall be selected for moisture and density testing. Determine the in-place density using the nuclear gauge in direct transmission mode. (Determine moisture in accordance with Materials I.M. 334.) During the first 2 day's testing, sample approximately 1000 grams of recycled ACC at each test location to determine the in-place moisture content. Using the nuclear gauge moisture content measurements and the in-place moisture content measurements, determine a correction factor to apply to the subsequent nuclear gauge moisture measurements after at least 10 tests are taken.

   Determine correction factor in kg/m³ (lb./ft.³) using the following formulas:

   Actual in-place moisture in kg/m³ (lb./ft.³) (minimum of 10 sites):

$$\text{Actual Moisture} = \frac{(\text{OVEN DRY \% MOISTURE})(\text{GAUGE WET DENSITY})}{\text{OVEN DRY \% MOISTURE} + 100}$$

   Example:

   Gauge Wet Density = 2090.6 kg/m³ (130.5 lb./ft.³)
   Oven Dry % Moisture = 2.3%

$$\text{Actual In-Place Moisture} = \frac{(2.3)(2090.6)}{2.3+100} = \frac{4808.38}{102.3} = 47\ \text{kg/m}^3 = \frac{(2.3)\ \text{x}\ (130.5)}{2.3+100} = \frac{300.2}{102.3} = 2.9\ \text{lb./ft.}^3$$

   Correction factor in kg/m³ (lb./ft.³):

   Determine the average of 10 (or more) actual moisture contents obtained using the above equation.

   Determine the average of 10 (or more) gauge moisture readings obtained at moisture sample sites.

   CORRECTION FACTOR = AVG GAUGE MOISTURE - AVG ACTUAL MOISTURE

Average of Gauge Moisture	177.8	11.1
Average of Actual In-Place Moisture	- 57.7	- 3.6
Correction Factor:	120.1 kg/m³	7.5 lb./ft.³

This correction factor may seem large due to the fact that the nuclear gauge measures both asphalt and water in the moisture reading. The following is an example (in English units) of a field book entry for showing the determination of a correction factor:

FIELD MOISTURE TEST

GAUGE WET DENSITY WD PCF	GAUGE MOISTURE CONTENT M GAUGE PCF	WET WEIGHT OF SAMPLE W1 %	OVEN DRY WEIGHT OF SAMPLE W2 %	PERCENT MOISTURE (W1-W2)/W2*100	ACTUAL IN-PLACE MOISTURE CONTENT M OVEN DRY PCF	CORRECTION FACTOR PCF
130.5	10.5	1250	1222	2.3	2.9	7.6
129.5	11.3	1390	1345	3.3	4.1	7.2
131.4	11.7	1268	1233	2.8	3.6	8.1
128.9	12.8	1111	1078	3.1	3.9	8.9
129.0	10.6	1234	1200	2.8	3.5	7.1
124.3	9.5	1254	1221	2.7	3.3	6.2
128.5	11.9	1299	1266	2.6	3.3	8.6
131.8	10.6	1433	1398	2.5	3.2	7.4
130.2	11.3	1156	1111	4.1	5.1	6.2
129.9	11.0	1453	1413	2.8	3.5	7.5
AVG. 129.4	11.1			2.9	3.6	7.5

NOTE: Any significant change in the characteristics or components of the surface being recycled requires a new correction factor to be established.

2. Determine the dry density of each subsequent test location using the formula:

   DRY DENSITY=GAUGE WET DENSITY - GAUGE MOISTURE + CORRECTION FACTOR

   Example:

Field Compacted Gauge Wet Density	2090.6	=	130.5 lb./ft.^{3}
Gauge Moisture	-168.2	=	-10.5 lb./ft.^{3}
Correction Factor	+120.2	=	7.5 lb./ft.^{3}
FIELD COMPACTED DRY DENSITY	2042.6 kg/m^3	=	127.5 lb./ft.^{3}

3. Determine the percent of Dry Marshall Density by the following formula:

$$\%\,\text{Marshall Density} = \frac{\text{Field Compacted Dry Density (100)}}{\text{Marshall Dry Density}}$$

   Report percent of density to three significant figures to the right of the decimal.

4. Determine compliance with specification as outlined in Materials I.M. 508 under section entitled, Calculation of Quality Index for Density.

REPORT

Report daily results on Form #7. On top of Form #7 place the note **Cold-In-Place ACC** Recycling Base. (See below for sample Plant Report Form.)

Iowa Department of Transportation

DAILY PLANT REPORT

~~BITUMINOUS TREATED BASE, ASPHALT CONCRETE~~
Cold-in-Place ACC Recycling (Base)

County: Marion
Project: SN-9764(9)--51-64
Contract No: 12345
Date: 6-20-92
Report No: 1

Contractor: Joe's Asphalt Rejuvinators — Plant Location: ______
Plant Type: ______ Make: ______ Pollution Equipment: ______ Resident Engineer: JAMES JAMESON
Plant Type: ______ Class: ______ Size: ______ Crushed Aggr. Sources: ______ Recycle Source: ______
Asphalt Source & Grade: ______ Sand Sources: ______ Plant Operated: ______ A.M. to ______ P.M. Mix No: ______

SIEVE ANALYSIS OF COMBINED AGGREGATES

SAMPLE		SIEVE NO. - % PASSING											
Job Mix Formula - Limits													
Time	Compl.	1½	1	¾	½	⅜	4	8	16	30	50	100	200

SAMPLES SUBMITTED		SAMPLES SUBMITTED	
Materials	Senders No.	Materials	Senders No.
HFE-300	1A	HFE-300	1B
MIX	M-1A	MIX	M-1B
CSS-1	1C		

Intended Added ______ % A.C. Tank Meas. ______ % A.C.
Intended Total ______ % A.C. Total ______ % A.C.

LAB DEN. 128.1

DENSITY RECORD / **SOLID DEN.**

Course Laid	Station	℄ Refer	Date Laid	* (1)	Density	% Density	% Voids
C-I-PLACE	20+71	4' RT	6-20-92	3	121.4	94.770	
	40+31	6' RT	↓	3	122.8	95.863	
	48+78	5' RT		3	121.8	95.082	
	60+00	9' RT		3	122.9	95.941	
	62+35	2' RT		3	122.8	95.863	
	65+04	7' RT		3	123.6	96.487	
	68+27	3' RT		3	122.0	95.238	
				AVG.	122.5	95.606	

TEMPERATURE RECORD

Time	7	9	11	1	3	5
Air						
A.C.						
Aggr.						
Mix						
Mat						

RECYCLED MIX ONLY

Total RAP Used Tons (Totalizer) ______
Total Aggr. Used Tons ______
RAP Used % (Target) ______ (Actual) ______
Aggr. Used % (Target) ______ (Actual) ______

ALL MATERIALS DELIVERIES

Type	Car or Ticket No	Total Quantity
HFE-300	21008	6247 GAL.
HFE-300	21010	6311 GAL.
CSS-1	142	6166 GAL.

Avg. Field Density Lot #1 ______
Avg. Field Density Lot #2 ______
Acceptance Fines/Bitumen Ratio =
Ave. % Field Voids =
% voids = [ ]
Std. (Density) = $\frac{95.606 - 92}{0.596} = 6.05$
(Show Calculation)

STANDARD DEVIATION = 0.596

PRODUCTION AND PLACEMENT RECORD

* (2)	Side	Course Laid	From Station to Station	Tons Today	Tons To Date
3	RT	Cold-IN-PLACE Recy.	0+10 to 69+50	21936.4 SQ. YDS.	21936.4 SQ. YDS.

Acceptance Cold Feed (Certified Projects Only)	1	¾	½	⅜	4	8	16	30	50	100	200

COMMENTS

Acceptance Fines/Bitumen Ratio =

COMMENTS. Delays, Breakdowns, Corrective Action, etc.
* In parens: (1) Actual, (2) Intended
Bituminous Treated Base: Enter % Moisture in % Voids Column

Signed: Sally Johnson (Inspector) Cert. #9999